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In this program (NAG 2-548), we planned to perform a detailed spectroscopic investigation of periodic comet Brorsen-Metcalf (1989o) in the wavelength region near $\lambda \sim 2.7 \mu\text{m}$ from NASA's Kuiper Airborne Observatory (KAO). Water is the dominant volatile constituent of cometary nuclei, and this spectral region is rich in the signatures of the various forms of water: ordinary gaseous water, water of hydration, and clusters of water molecules. We had hoped to use high resolution spectroscopy to measure water production rates, rotational temperatures in the coma, outflow velocities, and the water ortho-to-para ratio. We had also hoped to use moderate resolution spectroscopy to measure broader emission features, such as those produced by hydrated minerals and water clusters. Unfortunately, circumstances (as described below) conspired to prevent us from achieving the scientific objectives of this program.

Comet Brorsen-Metcalf was not recovered until July 4, 1989, at which time we discovered that the comet's return to perihelion was ~ 17 days earlier than predicted. Since the planned observation date was so close to the recovery date, the observing schedule could not be changed by the full 17 days. Thus, we were forced to observe the comet at smaller geocentric radial velocities than normal, which resulted in higher atmospheric absorption. Nevertheless, we still thought that we could achieve a significant fraction of our original goal under these conditions.

We observed comet Brorsen-Metcalf on July 29.5 UT, July 30.5 UT, and on August 1.5 UT. We experienced anomalous instrument performance on the first two dates, preventing us from obtaining useful data. The instrument was fixed for the third flight, but the atmospheric absorption was greatest on this date. Inspection of the quick-look data indicated that we were unlikely to achieve even a small fraction of our original objectives, so we made the decision to cancel a fourth observation attempt.

Subsequent, more detailed analysis of the data from the third flight showed that we detected a single water ro-vibrational line in the comet (the $1_{01} - 0_{00}$ para line at 3779.49 cm^{-1}). Using a "reasonable" estimate (based on our experience observing other comets) for the fraction of the total band intensity contained in this single line, we calculate that the water production rate of Comet Brorsen-Metcalf was $\sim 5 \times 10^{28} \text{ molecules sec}^{-1}$ when the comet's heliocentric distance was 1.03 AU. This value is consistent with the water production rates derived from ultraviolet and radio observations of OH , and from visible observations of $[OI]$. Since our result adds nothing new to our knowledge about Comet Brorsen-Metcalf, and since we achieved only a small fraction of our original scientific objectives, we have not written any papers describing our observations. Furthermore, we do not anticipate writing a paper in the future.

Despite the fact that we have not published any results from our program, the Brorsen-Metcalf observations did serve several useful purposes. First, in support of this program we have improved our ability to model the atmospheric transmittance. We have expended considerable effort during the past two years identifying the sources of opacity during KAO observations (both outside and inside the airplane), and we now have considerable confidence in our ability to model accurately real observational conditions. Second, this program has shown us exactly what we can and *cannot* accomplish during KAO observations of comets. Unless there is a significant improvement in the instrument's sensitivity, we now recognize

1

that significant results can only be achieved on fairly bright comets (having water production rates $\geq 2 \times 10^{29}$ when the heliocentric and geocentric distances are about 1 AU) observed when the geocentric radial velocity is $\geq 20 \text{ km sec}^{-1}$. Finally, during the past two years we have used the resources provided by the Brorsen-Metcalf program to continue our analysis of the data obtained during KAO observations of Comets Halley and Wilson (1987 VI). The Halley and Wilson programs had the same scientific objectives as the Brorsen-Metcalf program, so work in support of one automatically furthers progress on the others.